

Bihormonal control of blood glucose in people with type 1 diabetes - DTU Orbit (08/11/2017)

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This paper presents a bihormonal artificial pancreas (AP) for people with type 1 diabetes (T1D) designed to provide a safe blood glucose control with minimal use of glucagon. The control algorithm uses insulin as well as glucagon to prevent hyper- and hypoglycemia. We employ a novel prediction-based activation of glucagon administration. The control algorithm consists of a Kalman filter, an insulin infusion model predictive controller (MPC), a proportional-derivative (PD) controller for glucagon infusion, and a meal time insulin bolus calculator. The PD controller is activated if the Kalman filter predicts hypoglycemia. Predictions utilize an ARMAX model describing glucose-insulin and glucose-glucagon dynamics. The model parameters are estimated from basic patient-specific data. A continuous glucose monitor provides feedback. We test the control algorithm using a simulation model with time-varying parameters available for 3 patients. We consider a simulation scenario where meals are estimated correctly as well as overestimated by 30%. The simulation results demonstrate that during normal operation, the controller only needs insulin and does not need glucagon. During unexpected events, such as insulin overdose due to an overestimated meal, the control algorithm uses glucagon efficiently to avoid severe hypoglycemia.

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